Ineffectiveness of Sulfur-based Odors as Nesting Deterrents Against European Starlings[1]

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Abstract. **Sulfurous volatiles have been shown to elicit avoidance behavior by snow geese (*Chen caerulescens* Linnaeus), possibly because of their association with potentially toxic levels of selenium in some plant species. We questioned whether an avoidance response to sulfur and sulfur-based products might be exhibited by other avian species, specifically European starlings (*Sturnus vulgaris* L.) and whether the behavior might extend beyond the feeding context (that is, negatively affecting nesting). The European starling is an omnivorous species with a well-developed olfactory capability and can distinguish between plant volatiles when selecting nest material and, therefore, could possibly detect the presence of sulfur. Our objectives were to evaluate Deer Away® Big Game Repellent (BGR, composed of decaying putrescent whole egg solids) and powdered sulfur (99.98% pure) as nesting deterrents against European starlings. We distributed 3 treatments (including control) in a randomized design among 100 nest boxes attached to utility poles in Northern Ohio. Starlings nested in 81% of the nest boxes and other species in 11%, while 8% of the boxes were not occupied. There was no difference among groups in the proportion of boxes occupied by starlings. However, we found an absolute difference in measures of nesting activity across treatments that favored controls. Particularly, the lag in the mean (SD not included because of non-normal data) Julian date for the appearance of the first egg (control: 134, BGR: 138, sulfur: 138) in treated boxes might reflect occupation by younger, less experienced starlings. We conclude, however, that BGR and sulfur are not effective nesting deterrents against starlings, although they might be useful in enhancing other deterrents.**

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INTRODUCTION

The European starling (*Sturnus vulgaris* Linnaeus; hereafter referred to as starling) is an aggressive, opportunistic cavity nester often out-competing native species and causing conflicts with humans. For example, the species is well adapted to cultivated areas and is recognized as a threat to fruit and grain production (Feare 1984). Also, starlings nesting in and on airport hangers, commercial structures, and residential buildings pose health and physical dangers (Dolbeer and others 1988). Fecal material from nesting birds can spread disease and cause immediate property damage and long-term structural deterioration (Belant and others 1998). Further, birds nesting in and around airport property can also present a collision danger to aircraft (Cleary and others 2002). Reliable nesting deterrents are currently not available and lethal control is usually not desirable or feasible (Belant and others 1998; Clark 1998). The development of a reliable nesting deterrent, while not necessarily effecting measurable changes in vital population rates, may offer site-specific damage reduction.

Clark (1997) noted the importance of chemical senses in birds, but also the infrequency in which these senses (that is, olfaction, gustation, and chemesthesis) are investigated relative to species ecology (for example, management-related applications). For example, starlings have a higher level of odor acuity than do other passerines studied (Clark and Mason 1987). Clark and Smeraski (1990) suggested that starling odor acuity peaks during the breeding season, as demonstrated by the selection of green vegetation for nesting. Despite this temporal peak in starling odor acuity, Dolbeer and others (1988) and Belant and others (1998) demonstrated that naphthalene and phenethyl alcohol, respectively, were ineffective as odor-based nesting deterrents.

In the context of feeding, however, unpublished observations, noted in Mason and Clark (1996), suggest that snow geese (*Chen caerulescens* L.) will avoid high concentrations of Deer Away® Big Game Repellent (IntAgra, Minneapolis, MN, USA) due to the production of sulfurous volatiles. Specifically, snow geese might avoid BGR-treated fields because of an association of sulfur odor with potentially toxic levels of selenium (Se) in some plants. Sulfur-based repellents such as BGR, which contains putrescent whole egg solids as the active ingredient (AI) were originally developed as feeding deterrents against deer and other mammals (Swihart and Conover 1990, Mason and others 1999).

We hypothesized that sulfur-based odors might elicit a similar response by starlings, but in the context of selection of nest cavities (that is, due to the potential association with Se toxicity in plant material used for nesting, as well as an association with addled eggs). Our objectives were to evaluate Deer Away® Big Game Repellent (composed of decaying putrescent whole egg solids) and powdered sulfur (99.98% pure) as nesting deterrents against European starlings.

MATERIALS AND METHODS

During 2001, we used 100 identical wooden nest boxes located 2.5 to 3.0 m from the ground on wooden

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utility poles to test two candidate chemical deterrents against nesting starlings. The nest boxes were located inside the 2200-ha NASA Plum Brook Station, Erie County, OH. The boxes (28 × 13 × 17 cm) were at least 240 m apart. We wrapped an aluminum predator guard around each utility pole below the box to prevent predation from the ground. Each box had a 5.1 cm diameter hole as the entrance, a wooden perch, and a sliding removable roof. We placed a wooden block, drilled to hold a 9-dram (approximately 35 ml) plastic pharmacy vial (7.0 cm long and 3.0 cm in diameter), against the back wall of the box.

On 2 May 2001, treatments were assigned in a randomized fashion among the boxes (BGR: n = 33; 99.98% pure powdered sulfur: n = 33; control: n = 34). The treatments and control were placed into the plastic vials. The BGR, mixed as per label guidelines, contained 6.0 g of putrescent whole egg solids and 6.0 g of carrier, water. We therefore used 6.0 g of 99.98% powdered sulfur to correlate with the 6.0 g of AI in BGR. Powdered sulfur is not miscible with water and was, therefore, used in the powdered form. We placed control vials into the boxes empty because the actual control, water (that is, the carrier in BGR), is common and familiar to the starling and would rapidly evaporate without odor. The effective life of BGR, if applied as directed as a contact repellent, is up to 3 months (longer than our study period), although we used it as an odor-based repellent. We perforated the plastic cap on the vial and wrapped rubber bands around the vial and wooden block to secure the vial in position. We then raised the aluminum doors (in place since July 2000 to prevent premature entrance into the boxes) from covering the entrance holes.

We recorded nest-building status, species occupying the box, and the number of eggs and young once per week from 9 May to 11 July 2001. The treatments were not replaced for the duration of the study since they continued to provide sulfurous odor to humans.

We hypothesized that there would be no difference among treatments in occupation of nest boxes by starlings, nor in reproductive parameters. We used a Chi-square test to evaluate, among treatments, the number of boxes (N = 100) with nests containing at least one starling egg and the number of boxes with starling nestlings. Also, we recorded the Julian date of the first starling egg per nest (that is, the clutch initiation date) and evaluated these data for normality (PROC UNIVARIATE/ NORMAL OPTION; SAS 1987). Because these data were non-normal, we used the nonparametric Kruskal-Wallis test (PROC NPAR1WAY; SAS 1999) to evaluate differences in the date of nest initiation among treatments. Likewise, we evaluated potential differences in clutch size and the number of nestlings among treatments by use of the Kruskal-Wallis test. We made all statistical comparisons at the critical level of alpha = 0.05.

RESULTS

Starlings nested in 81% of the nest boxes and, when including all other species, 92% of the boxes were occupied over the course of the study (Table 1). There was no difference among treatments in number of boxes occupied by starlings (that is, nests with starling eggs; Table 1), nor in the number of boxes with starling nestlings (χ^2 approximation = 0.823, df = 2, P = 0.797). In addition, we observed no difference among treatments in the clutch initiation date (Kruskal-Wallis χ^2 approximation = 4.82, df = 2, P = 0.090), clutch size (χ^2

TABLE 1

Nesting activity of European starlings in nest boxes treated with BGR[1], sulfur, and control during an experiment in Erie County, OH, USA, 9 May through 27 July 2001.

Nest Boxes	BGR	Sulfur[2]	Control
Available	33	33	34
With nests	26	27	28
With eggs	26	27	28
With nestlings	23	21	25
Mean (range) Julian date	138	138	134
of first egg	(129–157)	(129–157)	(129–143)
Mean (range) clutch size	4.2	4.3	4.7
	(1–6)	(1–6)	(2–7)
Mean (range) no. of	3.2	3.6	3.7
nestlings	(1–6)	(1–5)	(1–5)
With other species nesting	4	4	3

[1]Deer Away® Big Game Repellent (IntAgra, Minneapolis, MN, USA).
[2]99.98% powdered sulfur (S).

approximation = 2.58, df = 2, $P = 0.275$), or the number of nestlings per starling nest (χ^2 approximation = 2.21, df = 2, $P = 0.332$; Table 1). However we found an absolute difference, favoring controls, in all measures of nesting activity across treatments (Table 1). In addition, 11 nests (control 2, BGR 4, sulfur 5) failed out of the 81 that were occupied by starlings.

Three species other than starlings nested in the nest boxes: eastern bluebird (*Sialia sialis* L.), 8 nests; house wren (*Troglodytes aedon* Vieillot), 1 nest; and tree swallow (*Tachycineta bicolor* V.), 2 nests (Table 1). Among the 8 boxes that did not contain a nest during the study, 3 were treated with BGR, 2 with sulfur, and 3 served as controls.

DISCUSSION

The olfactory capability of the starling is well documented (Clark and Mason 1987; Clark and Smeraski 1990), and researchers have sought starling nest deterrents based on this sensory pathway (Dolbeer and others 1988; Belant and others 1998). In this study, BGR and sulfur were ineffective as odor-based starling nest deterrents when applied at 6.0 g of AI. However, an absolute difference, favoring control nests, was apparent across treatments in all measures of nesting activity (Table 1). Particularly, the mean date of nest initiation was 4 days earlier in control versus treatment boxes. This difference might be attributed to the hierarchy within the starling population in which the older, more mature individuals choose nesting sites first (Feare 1984). Thus, the more dominant starlings might have avoided the treated boxes due to the odor, occupying control boxes first and leaving only treated boxes available to less dominant birds. The inoccupation of 8 boxes during the study might be due to their location and site-specific characteristics (for example, the direction that the box faced or surrounding habitat features).

A second slight absolute difference was found in the mean clutch size among treatments (BGR = 4.2, Sulfur = 4.3, Control = 4.7). Again, this absolute difference might be due to younger females occupying treated boxes and laying fewer eggs (and subsequently producing fewer nestlings), likely an age-related characteristic (Feare 1984), rather than a physiological response to sulfur odor.

Because the odors of the treatments were strongly apparent and quite unpleasant to humans, we contend that testing at higher levels of the AI would minimize the value of any evidence of nest deterrence, particularly in areas that humans frequent. However, successful wildlife control measures typically comprise an integrated approach and are built upon a sound knowledge of the species' ecology (Dolbeer 1999). In this study, BGR and powdered sulfur might have contributed to the absolute differences in measures of nesting activity, particularly the mean clutch initiation date and clutch size between treatments and controls. We suggest, therefore, that using either substance in conjunction with other deterrent methods (visual or chemical) might be useful in determining whether the apparent biological effects could be enhanced to produce an effective nest deterrent method.

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